# PESTS NOT KNOWN TO OCCUR IN THE UNITED STATES OR OF LIMITED DISTRIBUTION, NO. 27: CITRUS CANKER

Prepared by USDA, APHIS, PPQ, Biological Assessment Support Staff, Federal Building Room 626, Hyattsville, MD 20782

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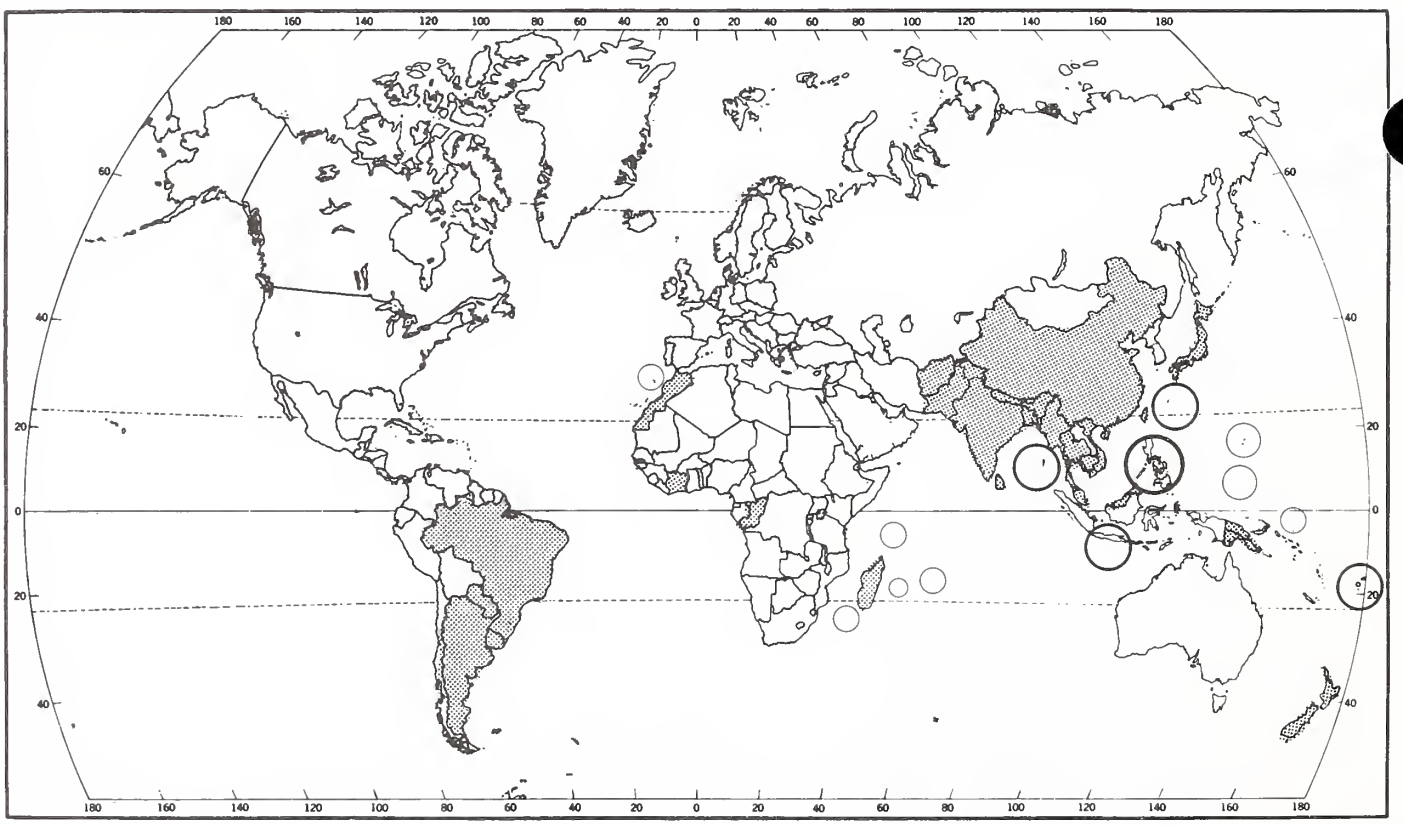
| Kingdom: Division | Procaryotae: The Bacteria |
| Part: Family | Gram-negative aerobic rods and cocci: Pseudomonadaceae |
| Pest | CITRUS CANKER or CITRUS BACTERIAL CANKER DISEASE (CBCD) (including biotypes/pathotypes A, B, and C) *Xanthomonas citri* (Hasse) Dowson 1939 or *Xanthomonas campestris* pv. *citri* (Hasse 1915) Dye 1978 |
| Selected Synonyms | Common names: Asiatic, A type, or true canker; cancrosis B, B type, or false canker; Galego (Mexican, Key) lime, or type C canker<br><br>Scientific names: *Bacillus citri* (Hasse) Holland 1920, *Bacterium citri* (Hasse) Doidge 1916, *Phytomonas citri* (Hasse) Bergey 1923, *Pseudomonas citri* Hasse 1915 (Kothekar 1978, personal communication). |
| Economic Importance | Citrus canker is a serious disease adversely affecting both the appearance and flavor of commercial citrus fruits. In all countries where it occurs this disease is one of the most damaging, especially where the pathogen causes defoliation and fruit drop. Rapid spread and the quick onset of high severity make necessary the immediate implementation of difficult and very expensive controls.<br><br>The citrus canker pathogen was first introduced into Florida around 1912 in a nursery in Monticello, and was recognized as a new disease in 1913. The source of infection appears to have been infected trifoliate-orange (*Poncirus trifoliata*) seedlings from Japan shipped to Alabama, Florida, and Texas.<br><br>Losses were heavy and drastic actions were required to eradicate this disease, one of the worst diseases of citrus ever introduced into the United States. Eradication was accomplished in Alabama (1927), Georgia (1918), Louisiana (1940), South Carolina (1917), and Texas (1943). The cost of eradication was $2,500,000 in Florida (1927) where 257,745 grove trees and 3,093,110 nursery trees were destroyed (Knorr 1957). |

General Distribution

The disease probably originated in China, was first observed in 1865, and since has spread to many citrus areas of the world. Afghanistan, Andaman Islands, Argentina, Bangladesh, Brazil, Burma, Caroline Islands, China, Congo, Guam, Fiji, Hong Kong, India, Indonesia (Java), Ivory Coast, Japan, Kampuchea, Madagascar, Malaysia, Mariana Islands, Mascara, Mauritius, Morocco, Nepal, New Guinea, New Zealand, Pakistan, Paraguay, Philippines, Reunion, Rodriguez Islands, Ryukyu Islands, Seychelles, Singapore, Sri Lanka, Taiwan, Thailand, Uruguay, and Vietnam (Kothekar 1978, Commonwealth Mycological Institute 1963).

Recently a disease resembling citrus canker has been reported from Colima, Mexico (unpublished 1982).



Xanthomonas citri distribution map prepared by USDA, APHIS, PPQ, Biological Assessment Support Staff

X. citri has been eradicated from Australia (Northern Territory), Mozambique, South Africa, and some parts of New Zealand (California Department of Agriculture 1971).

Hosts

This disease has a wide host range of genera in the family Rutaceae. The majority of commercially important Citrus spp. and their numerous varieties and hybrids are susceptible. Some wild citrus species, especially Poncirus trifoliata, Fortunella hindsii, F. japonica, and F. crassifolia are also susceptible (Kothekar 1978). There are three known biotypes or pathotypes of the pathogen to which hosts vary from highly susceptible to resistant. Grapefruit is most susceptible to type A strains, lemon is most susceptible to type B strains, and lime is most susceptible to type C strains.

In general, C. paradisi (grapefruit) is extremely susceptible. Poncirus trifoliata (trifoliate-orange) is probably next in susceptibility, followed in order by Citrus aurantiifolia (lime), C. sinensis (sweet orange), and C. limon (lemon), C. nobilis unshiu (satsuma orange), C. grandis (pummelo), C. reticulata (mandarin orange or tangerine), C. mitis (calamondin orange), and C. medica (citron). Fortunella margarita (oval kumquat) is highly resistant to citrus canker (Fawcett 1936).

The cancrosis B pathotype in Argentina is not usually found on grapefruit but is found commonly on C. aurantium (sour orange), lime, citron, and lemon. This form of the disease is most severe on lemon (Fig. 1). This biotype can be found on grapefruit, sweet orange, and mandarin orange planted near infected lemons (California Department of Agriculture 1971, personal communication).

Characters

Identification of the organism requires cultural techniques and microscopic examination as given in Bergey's manual, serological, and host pathogenicity testing (Nicholas 1979, Bach and others 1978, Buchanan and Gibbons 1974).

Several researchers have studied the characteristic growth of X. citri colonies on potato and found that it produces a yellow, lustrous bloom around which a narrow, white zone forms that subsequently disappears, leaving the entire potato slice enveloped in a thick, yellow slime (Kothekar 1978).

Characteristic Damage

The bacteria incite symptoms in the leaves, branches, and fruits of citrus. Characteristically, the first signs of the disease are tiny, greasy or watery, translucent patches on the lower leaf surfaces. At first the patches are yellowish brown and thicker than the surrounding tissue. The yellow brown patches eventually spread to the upper surface of the leaves where they are paler and reach a diameter of 3-4 mm (Fig. 6). Defoliation is directly related to disease severity. Goto and Yaguchi (1979) showed that if 20 percent of the leaf surface was affected by lesions, all leaves were lost. Most leaves with less than 5 percent lesions showed no defoliation.

On the branches and fruits the lesions are similar to those on the leaves but larger, up to 15 cm, and without the glazed areola which is characteristic of the leaves. The center cavities of the canker are more pronounced on fruits. Pummelos and grapefruits exhibit large lesions (up to 8 mm) and, although elevated at first, may become somewhat sunken as the fruit develops. To a slightly lesser extent it is also true of sweet oranges. Lesions on limes and lemons are decidedly smaller and rarely sunken (Knorr 1957).

The lesions enlarge, rupture the epidermis, and emerge as spongy tissues which usually rupture in the center as wrinkled, brown sponges. As these tiny carcinomalike sponges grow, they are surrounded by a glazed halo of greenish yellow which grades sharply into normal green tissue. A cavity forms in the center which has slightly raised edges. Patches eventually darken, lignify, become corky in appearance, and harden. Initially round, the patches become irregular in shape with growth with a marked craterlike aspect. Patch size and color vary according to the resistance of the variety and the environment (Kothekar 1978, Fawcett 1936) (Figs. 2 and 3).

Detection Notes

1. Citrus canker lesions on leaves are elevated and readily apparent to the touch on both surfaces, whereas, many injuries other than canker are not elevated in the same manner.

2. The lesions have a glazed margin with an oily appearance surrounding the eruption, a characteristic which is very distinctive and is not generally common to other diseased spots on citrus leaves.

(Fig. 1)

Xanthomonas sp. ("Cancrosis B") on lemon

3. Note with a hand lens craterlike canker lesions on the fruits and leaves.

4. Make a thin section from lesions and observe microscopically for bacterial ooze.

5. The distinguishing characters of diseases that can cause confusion with citrus canker are:

   (a) Leprosis or nailhead rust (now believed caused by or vectored by a false spider mite Brevipalpus australis, once believed caused by a fungus Cladosporium herbarum var. citricola) - brown lesions smooth (not corky or raised) and lack oily border (Figs. 4 and 5).

   (b) Anthracnose (Glomerella cingulata) - brown leaf spot papery (not corky or raised) and lacks yellow oily halo.

   (c) Lime anthracnose or anthracnose of Mexican lime (Gloeosporium limetticola) - raised brown lesions developing thick corky outgrowths on misshaped, cracked fruit (no corky leaf spots).

(d) Spine punctures - sunken spots, but rarely with halo.

(e) Scab (Elsinoe fawcettii) - wartlike growths on one side of leaf (individual lesion not raised on both sides of the leaf) (Fig. 7).

(f) Gum spot (Phomopsis citri) - flat lesions, small and hard (not corky or raised).

(g) Black spot (Guignardia citricarpa) - sunken spots on fruit turn black and lack oily border. (PNKTO No. 28).

(h) Juvenile spot - brown leafspot restricted to one side of leaf on trees less than 5 years old (grapefruit, rare on oranges or tangerines).

6. If available, submit one whole fruit showing symptoms and rinds of several others; plus any twigs or leaves showing symptoms (California Department of Agriculture 1971).

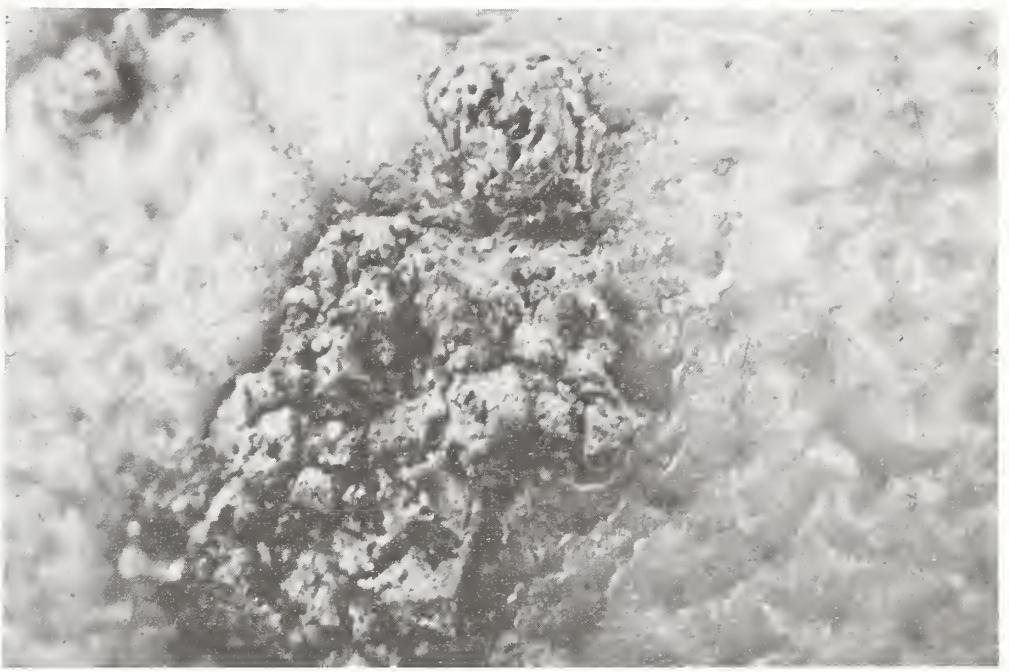
7. The determination of strain depends on serological testing and host inoculation as done at the Plant Research Laboratory, Agricultural Research Service (ARS), Frederick, MD, or at an ARS microbiological laboratory, Beltsville, MD (Nicholas 1979, Bach and others 1978, Prasad, Moses, and Reddy 1978).

Biology

X. citri spreads best at high temperatures and humidity. Saplings and young trees are more susceptible to the disease. Infection occurs readily at 20-30°C. The pathogen usually enters through wounds but can also pass through the stoma. Prolonged wet weather, which encourages new growth of the host, the most susceptible state, is most important in gaining entrance without wounds. A film of moisture is necessary for this to happen. The bacteria move into the intercellular spaces and cause tissue hypertrophy. When the central strip has dissolved, the cells are consumed and destroyed (Kothekar 1978, personal communication).

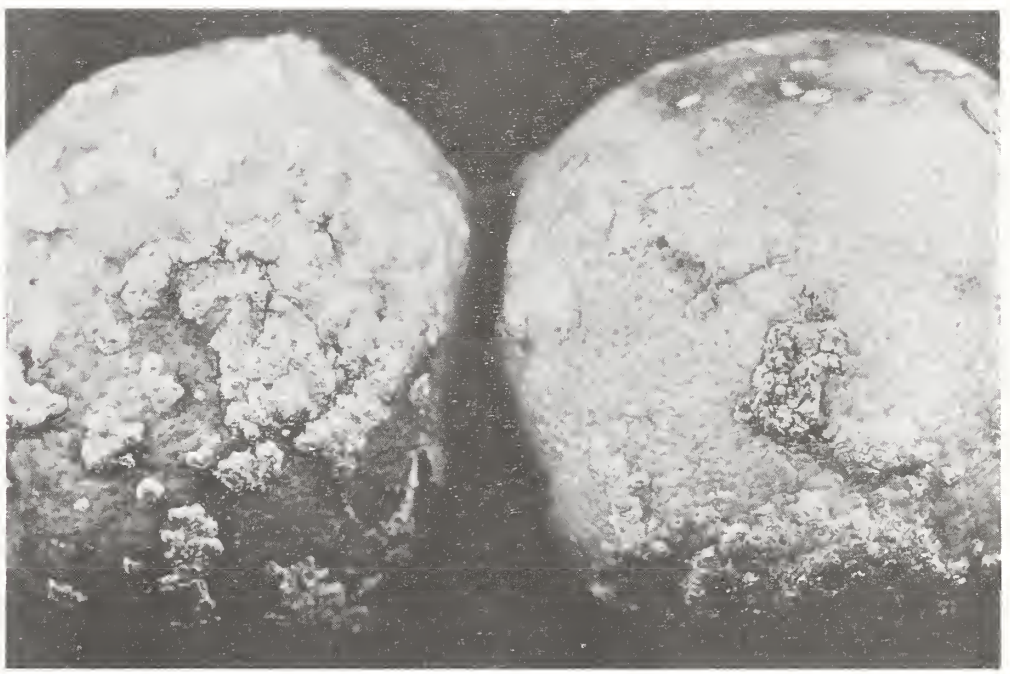
The bacteria are disseminated locally by wind driven rain and air currents, flood water, man, animals, and insects. The pathogen can be carried on fruit or other plant parts and nursery stocks to new areas. The bacterium overwinters primarily in stem cankers on summer

(Fig. 2)



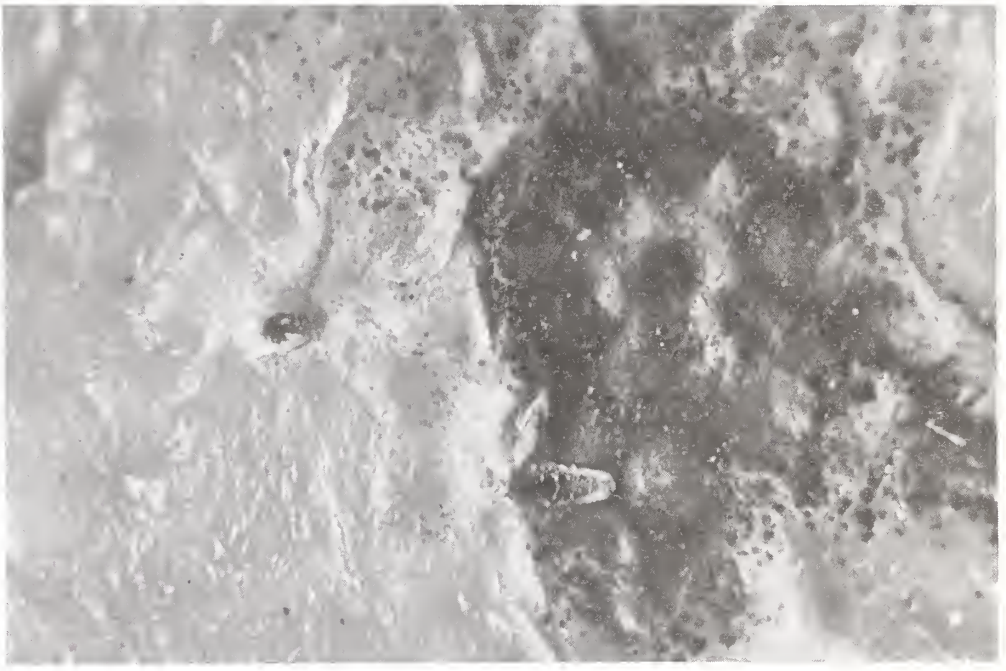
Xanthomonas citri. An enlarged lesion on sweet orange

(Fig. 3)



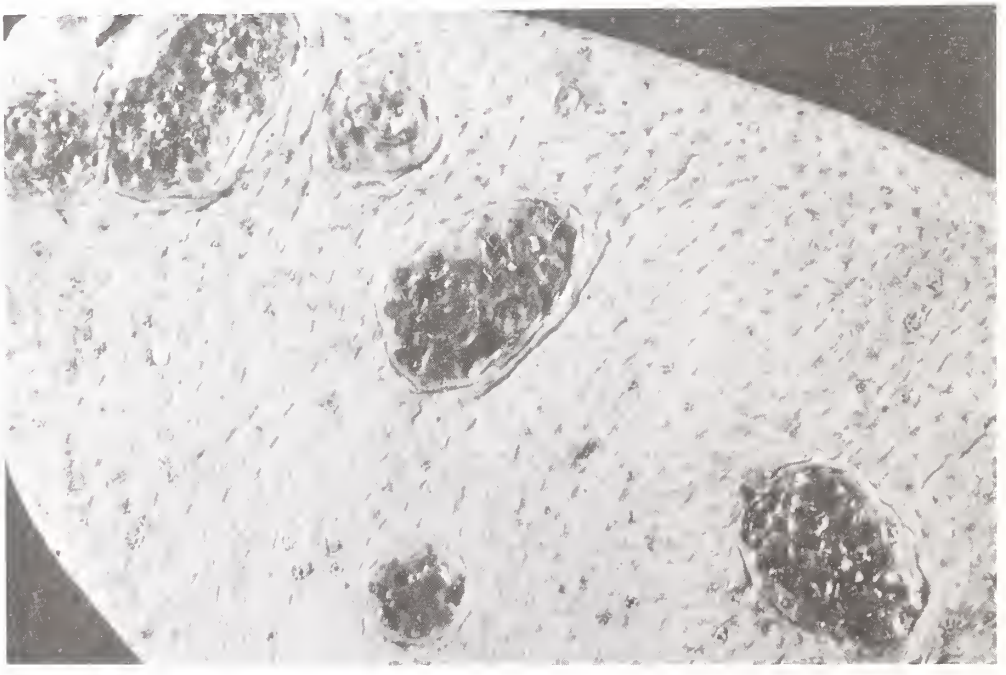
Xanthomonas citri on calamondin orange

(Fig. 4)



Leprosis of citrus (nailhead rust) on sweet orange
(Closeup of lesions)

(Fig. 5)



Leprosis of citrus (nailhead rust) on sweet orange

(Fig. 6)

Xanthomonas citri on lime leaf

(Fig. 7)

Elsinoe fawcettii on sour orange leaf

shoots. X. citri does not survive well in soil but remains viable in the remnants of infected plants, remaining dormant in bark and leaves at least 6 months, constituting a major source of infection.

The bacteria can also survive in grasses that grow in infected orchards. In Martinopolis, Sao Paulo State, Brazil, trees were reinfected in 1974 when planted on the same site from which citrus trees had been removed in 1957 due to citrus canker. The bacteria were found in the radicular system of a sourgrass Trichachne insularis (L.) Nees. Upon inoculation, the isolated bacteria were highly and consistently pathogenic to C. sinensis and aurantiifolia. The bacteria isolated from the sourgrass roots and rhizosphere were positively identified as X. citri (Lima and others 1977).

In Japan, X. citri was also found in another grass, Zoysia japonica (Goto, Ohta, and Okabe 1975). Another study showed that X. citri survived in the root system of another species Z. macrostachya (Goto, Toyoshima, and Tanaka 1978).

This information has implications for use in eradication, detection, and the possible introduction and spread of this pest. An inquiry is at present underway to check grass species in Florida to see if they are similar to those in South America.

Control

Control measures include exclusion by strict quarantines against the importation of citrus fruits, propagation materials, and nursery stock from areas known to have the disease. If the pathogen is introduced and the disease becomes established, all infected trees will be promptly and completely destroyed, using only properly trained and closely supervised inspectors. Growers should shift to commercially-resistant species and varieties and those susceptible varieties which have growing habits that will enable them to escape serious damage under local conditions (California Department of Agriculture 1971). Control after establishment is given in Kapur, Anand, and Cheema (1976).

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United States Department of Agriculture
Animal and Plant Health Inspection Service
Room 633-A, Federal Building
Hyattsville, Maryland 20782

Subject: Pests Not Known to Occur in the United States or of Limited Distribution, No. 27: Citrus Canker

Date: March 13, 1986

To: Recipients on Mailing List

We have revised the distribution for citrus canker (incited by Xanthomonas campestris pv. citri) as printed in APHIS 81-41, December 1982, because of several critical corrections and additions. For your convenience until the paper is revised, you may use the enclosure to replace "General Distribution" on page 2 and add to "Selected References" after page 12.



J. W. Lightfield
Assistant Director
Biological Assessment Support Staff
National Program Planning Staff
Plant Protection and Quarantine

Enclosure

General Distribution (Revised March 1986)

Commonwealth Mycological Institute (1978), unless otherwise cited, listed for citrus canker: Afghanistan, Andaman Islands, Argentina, Australia (only Home Island in Cocos (Keeling) Islands and Thursday Island (Jones et al. 1984)), Bangladesh, Brazil, Burma, Cambodia, Caroline Islands, China (includes Taiwan), Comoros (Aubert et al. 1982), Fiji, Hong Kong, India, Indonesia (Java), Ivory Coast, Japan (includes Ryukyu Islands), Korea, Madagascar, Malaysia, Mariana Islands, Mauritius, Mexico (Sanchez and Loaiza 1983), Mozambique, Nepal, Pakistan, Papua New Guinea, Paraguay, Philippines, Reunion (Moreira 1967), Rodriguez Islands, Saudi Arabia (Mlot 1984), Seychelles, Sri Lanka, Thailand, United Arab Emirates (el-Goorani in preparation), United States (only Florida (Schoulties and Miller 1985) and Guam), Uruguay, Vietnam, Yemen (Sanaa) (Dimitman 1984), and Zaire.

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